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RELATED PCT APPLICATION NUMBER: *PCT/US01/29504*

By Authority of the
COMMISSIONER OF PATENTS AND TRADEMARKS

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Certifying Officer

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PROVISIONAL APPLICATION COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION under 37 CFR 1.53(c)

PTO Transmittal Address:	Box PROVISIONAL PATENT APPLICATION Assistant Commissioner for Patents Washington, D.C. 20231
Filing Date	September 20, 2000
Inventor(s) Names	Scott Parkhill; Sayeed Ahmed; and Fred Fleet
Inventor(s) Residences & Citizenship	All reside in Dearborn, Michigan - United States (All are U.S. Citizens)
Invention Title	PRESS (NON-SOLDERED) CONTACTS FOR HIGH CURRENT ELECTRICAL CONNECT, IONS IN POWER MODULES
Attorney Docket No.:	5000.48208
Correspondence Address	ROYSTON, RAYZOR, VICKERY, NOVAK & DRUCE, L.L.P. David P. LeCroy 2000 Riverview Towers 111 Soledad San Antonio, Texas 78205 USA

This invention was NOT made by an agency of the United States Government or under contract with an agency of the United States Government.

ENCLOSURES

Specification (Pages):	6
Drawings (Sheets):	4
Small Entity Statement:	No
Other:	Addressed postcard to returned upon receipt.

CERTIFICATE OF MAILING BY "EXPRESS MAIL"

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9/20/00
Date

Signature of Person Mailing

David P. LeCroy
Printed Name of Person Mailing

Please charge Deposit Account No. 50-0432 in the amount of $150.00 (filing fee). A COPY OF THIS LETTER IS ATTACHED.

The Commissioner is hereby authorized to charge any additional fees under 37 C.F.R. §§ 1.16 and 1.17 which may be required at any other time during the prosecution of this application without specific authorization, or credit any overpayment to Deposit Account No. 50-0432.

Dated: 9/20/00

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PROVISIONAL PATENT APPLICATION

PRESS (NON-SOLDERED) CONTACTS FOR HIGH CURRENT ELECTRICAL CONNECT, IONS IN POWER MODULES

Inventor(s): Scott Parkhill
Sayeed Ahmed
Fred Flett

(U.S. Citizens)

Attorney Docket No.: 5000.48208

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September 20, 2000		David LeCroy
Date	Signature of Person Mailing	Printed Name of Person Mailing

PROVISIONAL PATENT APPLICATION

PRESS (NON-SOLDERED) CONTACTS FOR HIGH CURRENT ELECTRICAL CONNECT, IONS IN POWER MODULES

PROVISIONAL DESIGNATION:

This is a PROVISIONAL APPLICATION filed pursuant to 37 CFR 1.53(c).

BACKGROUND OF THE INVENTION:

Field of the Invention. The present invention relates to the field of electronics. More specifically, this invention relates to power inverter modules.

Disclosure Information. Inductive power losses associated with high frequency current switching in power inverter modules results in both the loss of efficiency and excess generation of heat due to the use of larger switching components to compensate for these losses. By minimizing the overall current loop size within the module for each current path configuration while encouraging the simultaneous counterflow of high currents, inductance losses are minimized.

In the standard power inverter module, direct current is converted to alternating current to power a three-phase motor. The route that the current must take is normally through the positive DC cable from a battery or other energy source to a bolted DC-positive connection on the module. Current then flows through the switching device to a motor phase lead connection. Current then returns from the motor through the module low side switches to the DC-negative bus, and then to ground.

The positive and negative DC terminals on the module are commonly attached only one end of the power module, forcing the current to travel further for some switching configurations than for others, resulting in uneven or inefficient motor performance. Additionally, these large current loops within the module, in conjunction with non-optimized bus and terminal design, lead to large internal inductances that reduce the module's switching efficiency and cause voltage overshoot.

To minimize the negative effects of ripple current associated with this switching process, large capacitors are generally placed in a parallel arrangement between the positive and negative DC connections. This is usually accomplished by bolting the two capacitor leads of each of a number of electrically parallel capacitors through two powder-coated or otherwise electrically isolated but planarly attached rigid metal

busbars. These busbars are heavy, difficult to manufacture, and consequently, very expensive.

Present inverter power module designs typically require wire bonding or direct soldering of power terminals or jumpers to obtain acceptably high current carrying capacity with minimal contact resistance. However, soldering large terminals and wire bonding are energy intensive and time consuming manufacturing operations.

SUMMARY OF THE INVENTION:

In the disclosed embodiment, the present invention alleviates the drawbacks described above with respect to known power modules. The present invention utilizes a solderless high power connection system for the DC interconnects and/or phase lead and jumper connections.

Such solderless high power connections include dimples, or spring loaded, bolted or clamped connections. Additionally, the connection can be insert-molded into the plastic housing assembly or post-assembled. Other advantages of the present invention include better thermal management in DC conductors, as well as simplified manufacturing/cost by simplifying/reducing the number of electrical contacts

The present invention utilizes laminated DBC or injection molded laminated lead frame within the power module in conjunction with a PCB busbar external to the module, as well as a unique module and system layout, thereby accomplishing minimization of both loss of efficiency and excess heat generation, as well as maximum power output per size and cost of the module.

In contrast to the prior art, the power module of the present invention combines the positive and negative DC busses into a laminated structure. The interconnects are designed to allow for symmetrical current flow and shorter current paths. This "in tegrated electronics" module combines three individual switching modules into a single integrated package, with the AC terminals on the module rather than on a PCB as is in the prior art.

The power module of the present invention utilizes a unique layout that not only consolidates all of the three high-low switch pairs into a single module, but also significantly reduces the overall module size. The module layout of the present invention also combines the internal positive and negative DC bus into a laminated structure running down the middle of the module between the high and low switch pairs with, not one, but three paired sets of positive and negative DC terminals. These DC terminals exiting the module are then soldered directly into an external DC bus composed of a conventional PCB with typical PCB-mounted capacitors, instead of

bolting to cables or metal bars attached to a metal DC bus.

The location of the internal DC bus between switch pairs and the multiple DC terminals, along with the directly attached external PCB-based DC busbar, ensure that current flow distance and loop size are minimized. The close proximity of the laminated internal DC bus permits magnetic coupling of the counter-flowing positive and negative DC currents, thereby permitting EMI and inductance cancellation.

The general beneficial effects described above apply generally to each of the exemplary descriptions and characterizations of the devices and mechanisms disclosed herein. The specific structures through which these benefits are delivered will be described in detail herein below.

BRIEF DESCRIPTION OF THE DRAWINGS:

In the following, the invention will be described in greater detail by way of examples and with reference to the attached drawings, in which:

Figure 1 is an exploded view of a power module according to the present invention;

Figure 2 is a top plan view of one embodiment of the base plate portion of the power module of the present invention showing the DC bus connections;

Figure 3 is a top plan view of another embodiment of the base plate portion of the power module of the present invention; and

Figure 4 is a side plan view of the substrate layer of the present invention.

DETAILED DESCRIPTION OF THE INVENTION:

As required, detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely exemplary of the invention that may be embodied in various and alternative forms. The figures are not necessarily to scale; some features may be exaggerated or minimized to show details of particular components. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present invention.

Furthermore, elements may be recited as being "coupled"; this terminology's use contemplates elements being connected together in such a way that there may be other components interstitially located between the specified elements, and that the elements so specified may be connected in fixed or movable relation one to the other. Certain components may be described as being "adjacent" to one another. In these instances,

it is expected that a relationship so characterized shall be interpreted to mean that the components are located proximate to one another, but not necessarily in contact with each other. Normally ther will be an absence of other components positioned therebetween, but this is not a requirement. Still further, some structural relationships or orientations may be designated with the word "substantially". In those cases, it is meant that the relationship or orientation is as described, with allowances for variations that do not effect the cooperation of the so described component or components.

Interconnects tend to be subject to defects, such as bending or breaking with use. Additionally, more time and therefore cost is required in adding interconnects or bonds. Referring to Figure 2, the green copper terminal is a potential application for a stressed contact. By creating dimples in the DBC, when the lead plastic frame shown as the solderless contact in Figure 4 is placed on top, the parts are pressed on top of the dimples clearing the contact, i.e., making the connection between the DBC substrate and the base plate.

Although the present invention has been described and illustrated in detail, it is to be clearly understood that the same is by way of illustration and example only, and is not to be taken as a limitation. The spirit and scope of the present invention are to be limited only by the terms of any claims presented hereafter.

Industrial Applicability. The present invention finds applicability in the electronics industries, and more specifically in power inverter modules. Of particular importance will be the invention's incorporation into

What is claimed is:

1. A method of improving high current carrying capacity in a power module comprising the steps of:
Utilizing a solderless high power connection system for the DC interconnects and/or phase lead and jumper connections.

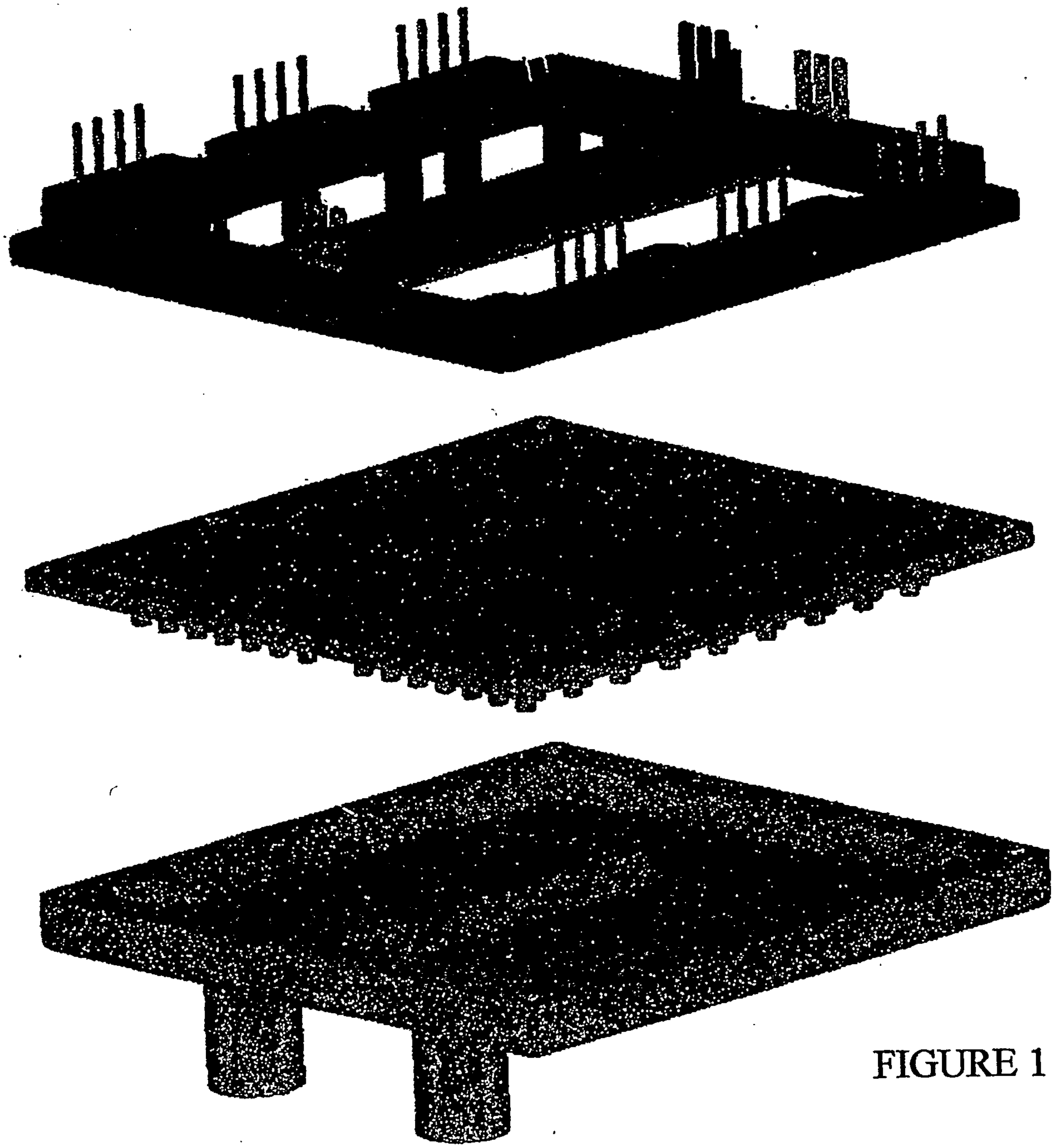
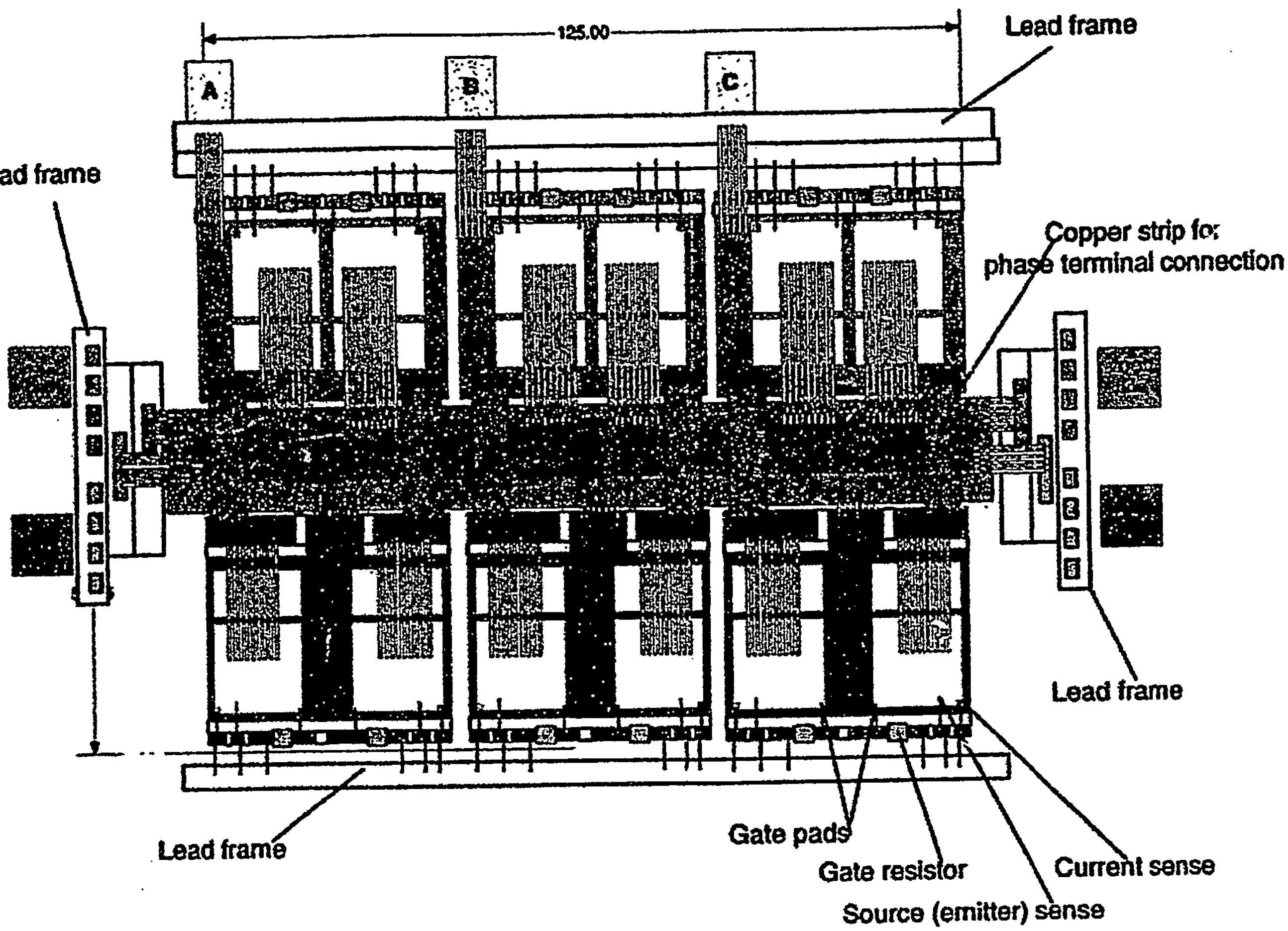


FIGURE 1

FIGURE 2


125.00
A
B
C
Lead frame
Lead frame
Copper strip for
phase terminal connection
Lead frame
Lead frame
Gate pads
Gate resistor
Current sense
Source (emitter) sense

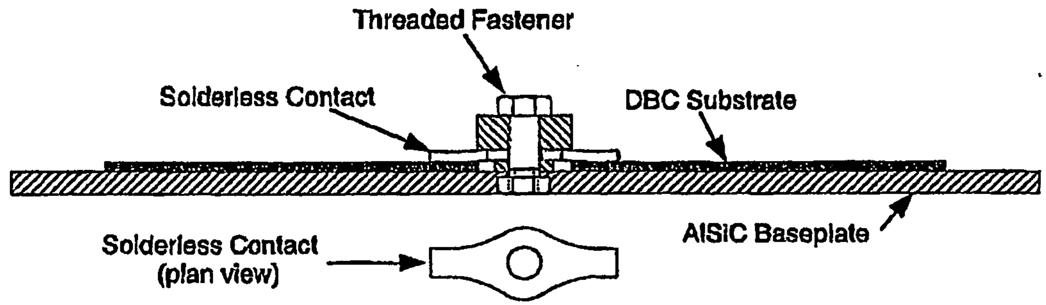

Threaded Fastener
Solderless Contact
DBC Substrate
AlSiC Baseplate
Solderless Contact
(plan view)

FIGURE 4